# Price, Yield and Rate Calculations for a Treasury Bill

These examples are provided for illustrative purposes only and are in no way a prediction of interest rates or prices on any bills, notes or bonds issued by the Treasury.

In order for the reader to follow the step-by-step calculations, these examples were prepared on an Excel spreadsheet using 15 decimals, with rounding at each step. For readers who use multi-decimal calculators, we recommend setting the calculator to its maximum decimal settings and then applying normal rounding procedures.

In actual practice, Treasury uses a mainframe and generally does not round prior to determining the final result. In the case of any discrepancies due to rounding, determinations by the Treasury shall be final.

## Calculate the Dollar Price for a Treasury Bill

### Description:
T-Bill 02/19/2004

### Variables / Inputs

<table>
<thead>
<tr>
<th>Issue Date:</th>
<th>01/22/2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity Date:</td>
<td>02/19/2004</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>0.800%</td>
</tr>
<tr>
<td>Days to Maturity:</td>
<td>28</td>
</tr>
<tr>
<td>Days in Year:</td>
<td>366</td>
</tr>
</tbody>
</table>

### Formula

\[
P = 100 \left( 1 - \frac{dr}{360} \right)
\]

1. \( P = 100 \left( 1 - \frac{0.0080 \times 28}{360} \right) \)
2. \( P = 100 \left( 1 - \frac{0.00622222222222}{360} \right) \)
3. \( P = 100 \left( \frac{0.99937777777778}{100} \right) \)
4. \( P = 99.937778 \) Rounded to 6 places

### Convert Price to Discount Rate

\[
d = \left[ \frac{100 - P}{100} \times \frac{360}{r} \right]
\]

1. \( d = \left[ \frac{100 - 99.937778}{100} \times \frac{360}{28} \right] \)
2. \( d = \left[ \frac{0.06222200000006}{100} \times 12.857142857142857 \right] \)
3. \( d = \left[ 0.00062222000000 \times 12.857142857142857 \right] \)
4. \( d = 0.007999971428571 \)
5. \( d = 0.800\% \)
Calculate Coupon Equivalent Yield
For bills of not more than one half-year to maturity

Equation
\[ i = \left( \frac{100 - P}{P} \right) \cdot \frac{y}{r} \]

Formula
\[ i = \left( \frac{100 - P}{P} \right) \cdot \left( \frac{y}{r} \right) \]

(1) \( i = \left( \left( 100 - \frac{99.937778}{99.937778} \right) \right) \cdot \left( \frac{366}{28} \right) \)
(2) \( i = \left( \frac{0.06222200000006}{99.937778} \right) \cdot \left( 13.071428571428571 \right) \)
(3) \( i = \left( \frac{0.000622607398776}{99.937778} \right) \cdot \left( 13.071428571428571 \right) \)
(4) \( i = 0.008138368141143 \)
(5) \( i = 0.814\% \)

Calculate Coupon Equivalent Yield
For bills of more than one half-year to maturity

The basic formula is:
\[ P \left[ 1 + \left( r - \frac{y}{2} \right) \left( \frac{i}{y} \right) \right] \left( 1 + \frac{i}{2} \right) = 100 \]

Which can be expressed the quadratic form of: \( ax^2 + bx + c = 0 \)
\[ i^2 \left[ \frac{r}{2y} - 0.25 \right] + i \left( \frac{r}{y} \right) + \left( \frac{P - 100}{P} \right) = 0 \]

In order to calculate the Coupon Equivalent Yield on a Treasury Bill you must first solve for the intermediate variables in the equation. In this formula they are addressed as: \( a \), \( b \), and \( c \).

Variables / Inputs

| Issue Date: | 06/07/1990 |
| Maturity Date: | 06/06/1991 |
| Discount Rate: | 7.65% |
| Price: | 92.265000 |
| Days to Maturity: | r = 364 (Jun. 07, 1990 to Jun. 06, 1991) |
| Days in Year: | y = 365 (Jun. 07, 1990 to Jun. 07, 1991) |

Formulas to be used

\[ i = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \]
\[ b = \frac{r}{y} \]
\[ a = \left( \frac{r}{2y} \right) - 0.25 \]
\[ c = \left( \frac{P - 100}{P} \right) \]

Begin by Solving for \( a \)
\[ a = \left( \frac{r}{2y} \right) - 0.25 \]
(1) \( a = \left( \frac{364}{2} \right) - 0.25 \)
(2) \( a = \left( \frac{364}{730} \right) - 0.25 \)
(3) \( a = 0.498630136986301 - 0.25 \)
(4) \( a = 0.248630136986301 \)
Next Solve for \( b \)
\[
b = \frac{r}{y}
\]

(1) \( b = \frac{364}{365} \)
(2) \( b = \frac{0.997260273972603}{y} \)

Next Solve for \( c \)
\[
c = \frac{(P - 100)}{P}
\]

(1) \( c = \frac{(92.265000 - 100)}{92.265000} \)
(2) \( c = \frac{-7.735}{92.265000} \)
(3) \( c = \frac{-0.083834606838996}{P} \)

Using the above calculated variables solve for the Investment Rate using the following formula.
Begin by populating the equation with the variables and then solving for Part A, Part B, and Part C.

Solve for \( i \)
\[
i = \frac{b + \sqrt{(b^2 - 4ac)}}{2a}
\]

(1) \( i = \frac{-0.997260273972603 + \sqrt{0.997260273972603^2 - 4 \times 0.048630136986301 \times -0.083834606838996}}{2 \times 0.497260273972602} \)

(2) \( i = \frac{-0.997260273972603 + \sqrt{0.994528054043911 - 0.083375239130289}}{0.497260273972602} \)

(3) \( i = \frac{-0.997260273972603 + \sqrt{1.077903293174200}}{0.497260273972602} \)

(4) \( i = \frac{-0.997260273972603 + 1.038221215914123}{0.497260273972602} \)

(5) \( i = \frac{0.040960941941520}{0.497260273972602} \)

(6) \( i = \frac{0.082373244124820}{0.497260273972602} \)
(7) \( i = 8.237\% \)

Sample Settlement Information

If the 6-decimal price per hundred is 99.937778, then:

<table>
<thead>
<tr>
<th>Face Amount</th>
<th>Settlement Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000,000.00</td>
<td>999,377.78</td>
</tr>
<tr>
<td>100,000,000.00</td>
<td>99,937,778.00</td>
</tr>
<tr>
<td>1,000,000,000.00</td>
<td>999,377,780.00</td>
</tr>
</tbody>
</table>